User manual for DVL/DVLC range

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1. FOREWORD

First of all, we thank you for your confidence purchasing one of our product, and confirm that we remain at your disposal for any assistance you may need or any problem you encounter when you are using this equipment.

This handbook has been supplied to you with a Digital Line Scan Camera from our DVL/DVLC Range.

For all additional information relating to this product, please contact :

LORD Ingénierie
ZA de Marly
BP 110
2, rue Auguste Fresnel
91410 Corbreuse - FRANCE

tél : (33) 1 64 551 551
fax : (33) 1 64 595 595
email : support@lord-ing.com

You may also call us if you would like us to investigate any changes in the product when it is employed in the OEM trade, or to design a product which meets your own specifications.

1.1 Warranty

The warranty is for **5 Years**, parts and labour, the equipment being returned to Lord Ingénierie. This period will be extended by any time out of service while repairs are effected under the warranty.

The warranty period will run from the date on which the equipment is accepted by the user.

The warranty covers:

- the replacement of parts recognised as defective, following examination by the quality control department of Lord Ingénierie,
- the costs of the labour expended on the repair of equipment.

The warranty does not cover:

- repairs made necessary by accidents to the equipment following failure to comply with the limiting conditions of use or precautions in use or impacts or shocks,
- repairs to equipment which has been modified or opened, even to a minor degree, by the user,
- repairs made necessary by accidents to the equipment following the use of accessories which have not been approved by Lord Ingénierie,
- repairs to equipment which has been damaged as a result of *force majeure*, defined as any event outside the control of the user or where his control is limited such as in the case of floods, war or other events leading to abnormal use of the equipment.

Lord Ingénierie will not be liable for any damages due to the consequences, direct or indirect, of an operating fault on any of its equipment.

During the whole of the warranty period, the responsibility of Lord Ingénierie will be limited to the replacement of defective parts. Transportation costs to the Lord Ingénierie factory will be the responsibility of the user, and those for the return journey will be covered by Lord Ingénierie.

The responsibility of Lord Ingénierie cannot be claimed in any other cases, and in particular with regard to fire, accidental damage, inspection by a standards inspector or any other reason.

2. LORD INGENIERIE RANGE OF PRODUCTS

Please find hereafter spreadsheet with our complete offer regarding line scan cameras, DVL/DVLC Range.

Digital monochrome line scan cameras - 16 bits

LORD Reference	Résolution	Pixel frequency	Size of pixels	Photo-sensitive area	Maximum line frequency	Dynamic range	Sensitivity	Electronic shutter	Lens mounts	Output video formats
	Number of pixels	MHz	µm x µm	mm x µm	kHz		Typical sensitivity at unity gain (lsb/lux.s)			
DVL512R	512	40	14 x 14	7,168 x 14	69,80	2 300	450 000	yes	C mount F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 (RS422 available at 20 MHz only) LVDS Camera Link
DVL1024R	1024	40	14 x 14	14,336 x 14	36,86	2 300	450 000	yes	C mount F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 (RS422 available at 20 MHz only) LVDS Camera Link
DVL2048RS	2048	2	14 x 56	28,672 x 56	0,94	1 150	7 860 000	no	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644)
DVL2048S	2048	5	14 x 14	28,672 x 14	2,34	1 800	1 310 000	yes	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644)
DVL2048T	2048	20	14 x 14	28,672 x 14	9,30	1 250	2 030 000	no	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL2048R	2048	40	14 x 14	28,672 x 14	18,96	2 200	450 000	yes	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 (RS422 available at 20 MHz only) LVDS Camera Link
DVL2098K	2098	20	14 x 14	29,372 x 14	9,09	5 900	300 000	yes	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL2500T	2500	20	14 x 7	35 x 7	7,69	1 100	600 000	emulated shutter	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL3750T	3750	20	14 x 7	52,5 x 7	5,19	800	1 000 000	emulated shutter	F-Nikon 24x36 Mamiya 645	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL5000T (20 MHz)	5000	20	7 x 7	35 x 7	3,85	2 300	300 000	no	F-Nikon 24x36 M42 screw mount Leica 39 with screws	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL5000T2 (40 MHz)	5000	40	7 x 7	35 x 7	7,69	2 000	300 000	emulated shutter	F-Nikon 24x36 42 à vis 39 à vis Leica	8 - 16 bits RS422 (RS422 available at 20 MHz only) 16 bits LVDS (RS644) camera link
DVL7500T (20 MHz)	7500	20	7 x 7	52,5 x 7	2,60	1 500	500 000	no	F-Nikon 24x36 Mamiya 645	8 - 16 bits RS422 16 bits LVDS (RS644) camera link
DVL7500T2 (40 MHz)	7500	40	7 x 7	52,5 x 7	5,19	1 350	500 000	emulated shutter	F-Nikon 24x36 Mamiya 645	8 - 16 bits RS422 (RS422 available at 20 MHz only) 16 bits LVDS (RS644) camera link

8 bits output are compatible with previous series of digital line scan cameras (CNL/CNLV seire)

(nd) Not disclosed

For the use of emulated shutter, please refer to the special notice

Digital color line scan camera - 16 bits

LORD Reference	Résolution	Pixel frequency	Size of pixels	Photo-sensitive area	Maximum line frequency	Dynamic range	Sensitivity	Electronic shutter	Lens mounts	Output video formats
	Number of pixels	MHz	µm x µm	mm x µm	kHz	0	Typical sensitivity at unity gain (lsb/lux.s)			
DVLC2098K	3 x 2098	3 x 20 = 60	14 x 14	3 x (29,372 x 14) - (pitch : 112)	9,26 at 60 MHz 3,09 at 20 MHz	5 000 at 60 MHz 6 150 at 20 MHz	nd	yes	F-Nikon 24x36 M42 with screws Leica 39 with screws	8 - 16 bits RS422 (RS422 available at 20 MHz only) 16 bits LVDS (RS644) camera link

DVLxxxxR cameras have an antiblooming. UV Sensitive cameras available for the DVLxxxxR.

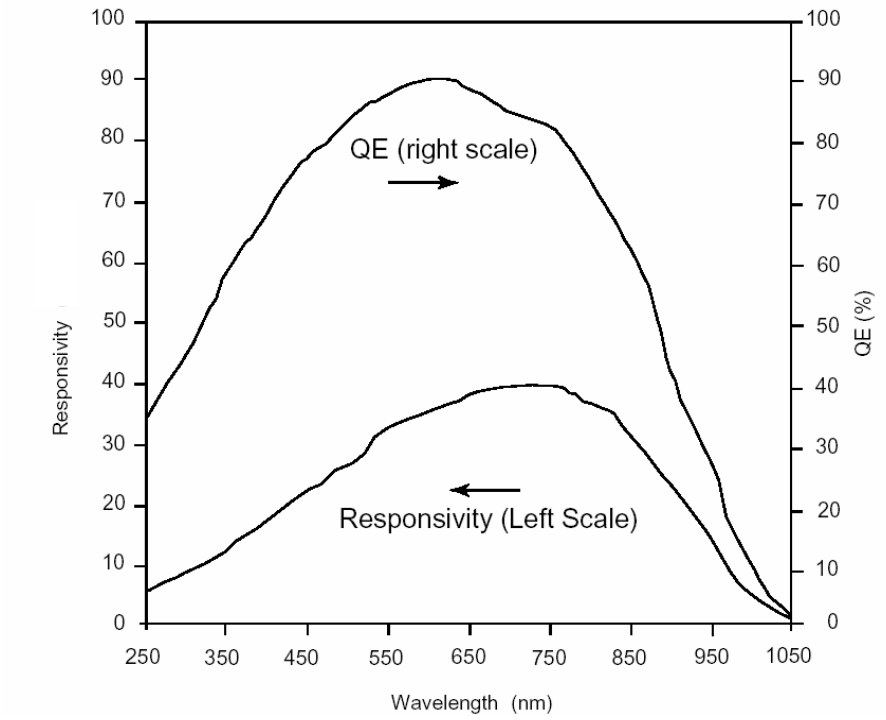
3. PERFORMANCES

3.1 Spectral response

The spectral response depends on the sensor used.
Here are the curves from the CCD manufacturer, given in relative units.

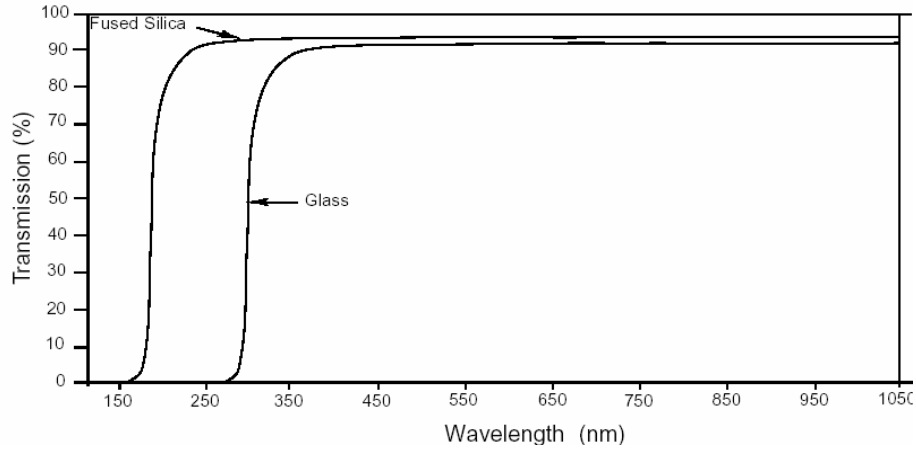
3.1.1 DVLXXXXR

Spectral sensitivity Curve

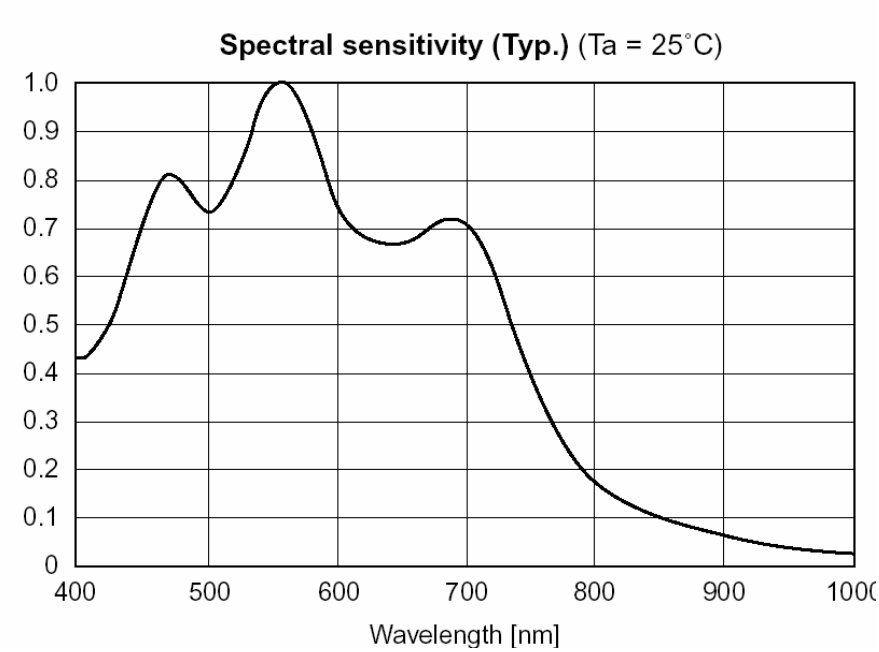


These cameras exist in UV version. This means that the window is made of fused silica, which is transparent to the UV light below 200 nm.

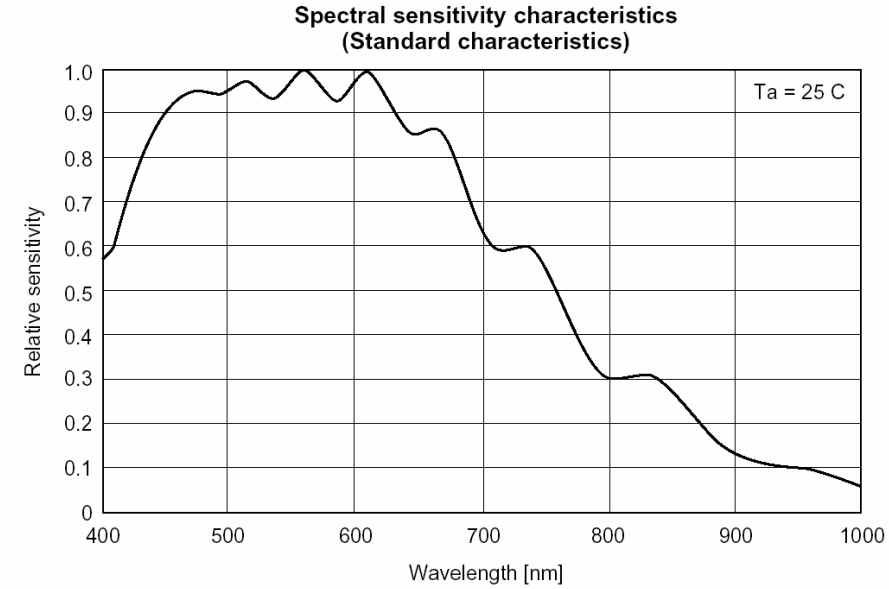
Window transmission curve



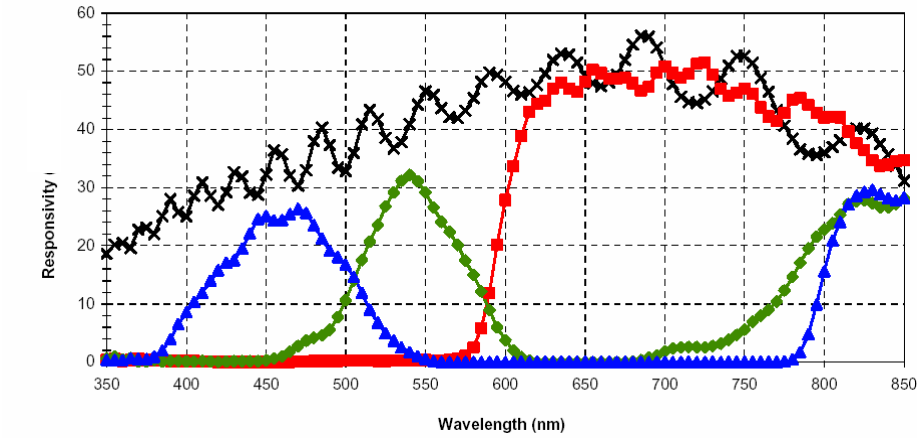
3.1.2 DVL2048RS



3.1.3 DVL2048S



3.1.4 DVL2098K / DVLC2098K



Note :

This curve is given for the sensor alone.

Inside the DVLC2098K, an optical filter is added (Shott BG38 2mm thick) in order to attenuate the IR response.

3.1.5 DVLXXXXT

Not disclosed

3.2 Sensitivity

	Peak sensitivity (typ)	Typical non uniformity	Maximum non uniformity
Units	LSB/lux.s	%	%
DVL512R	450 000	± 5	Nd
DVL1024R	450 000	± 5	Nd
DVL2048RS	7 860 000	± 5	± 10
DVL2048S	1 310 000	± 2	± 8
DVL2048T	2 030 000	± 3	± 10
DVL2048R	450 000	± 5	Nd
DVL2098K	300 000	± 2.5	± 5
DVL2500T	600 000	± 3	± 10
DVL3750T	1 000 000	± 3	± 10
DVL5000T	300 000	± 3	± 10
DVL5000T2	300 000	± 3	± 10
DVL7500T	500 000	± 3	± 10
DVL7500T2	500 000	± 3	± 10
DVLC2098K	ND	± 2.5	± 5

3.3 Noise performance

	Analog to Digital Converter	Noise in the Dark rms[1] (typical)	Dynamic range [2] (typical)
Units	bits	LSB (16 bits) [3]	--
DVL512R	12	29	2300
DVL1024R	12	29	2300
DVL2048RS	16	57	1150
DVL2048S	16	36	1800
DVL2048T	12	52	1250
DVL2048R	12	30	2200
DVL2098K	16	11	5900
DVL2500T	16	62	1100
DVL3750T	16	83	800
DVL5000T	16	31	2300
DVL5000T2	16	34	2000
DVL7500T	16	43	1500
DVL7500T2	16	49	1350
DVLC2098K @ 60MHz	16	13	5000
DVLC2098K @ 20MHz	16	10.7	6150

[1] Measurement method for the noise in the dark :

With the camera being in the dark, the value of noise is calculated as the root mean square of the substraction between 2 successive lines. This method gives a relevant value of how much the pixel levels fluctuate along time. As it is measured in the dark, this value does not include photon noise.

Note : for the DVLxxxxR, the rms noise is measured without acces to the user settings.

[2] Dynamic range is calculated as follows : Saturation Level / Noise in the dark

[3] For cameras based on either a 12 or a 16 bits wide converter, video is output on 16 bits (Least Significant bits padded with zeros for 12 bits signals). The noise performance is measured on the 16 bits wide video signal, so that the values in the table are directly comparable with each other.

4. MECHANICAL CHARACTERISTICS

4.1 Physical and environmental characteristics

Storage temperature :	-25 +80 °C
Temperature of use	0°C + 50°C
weight	780 g for F mount versions 1040 g for Mamiya 645 mount versions

4.2 Mechanical housing

Mounting of the camera is possible on the 4 sides.
One of them is a reference mounting surface and can be equipped with centering pins to allow repetitivity of positionning.

4.3 Pixel 1's location

When camera is mounted on the centering pins, and looking at the front side of the camera, the pixel number 1 is on the left side of the sensor area.

4.4 Lens mount

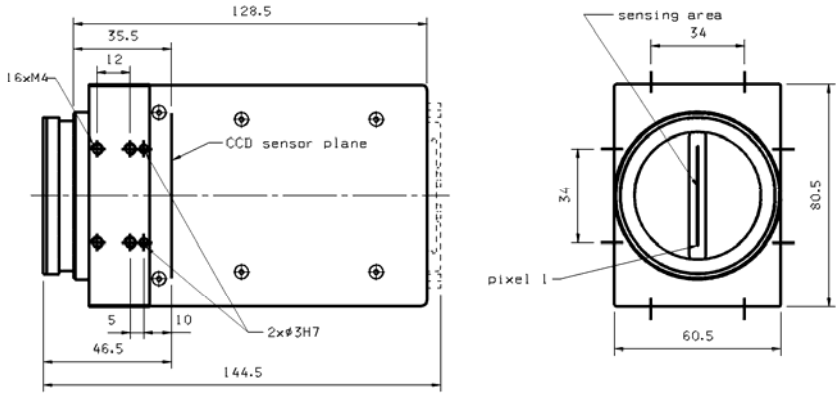
	Standard mount
DVL512R	C mount
DVL1024R	C mount
DVL2048RS	F mount
DVL2048S	F mount
DVL2048T	F mount
DVL2048R	F mount
DVL2098K	F mount
DVL2500T	F mount
DVL3750T	Mamiya 645
DVL5000T	F mount
DVL5000T2	F mount
DVL7500T	Mamiya 645
DVL7500T2	Mamiya 645
DVLC2098K	F mount

Lens mounts available unpon request:

F mount
C mount
M42 screw mount
Leica 39 with screws
Mamiya 645

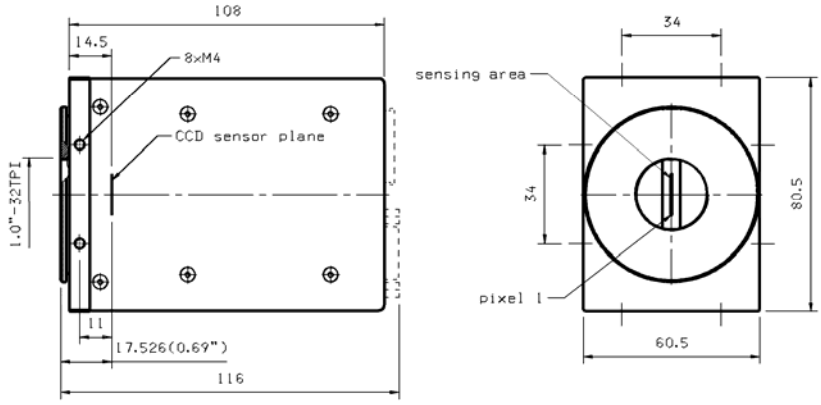
4.4.1 F-mount

Dimensions (mm)



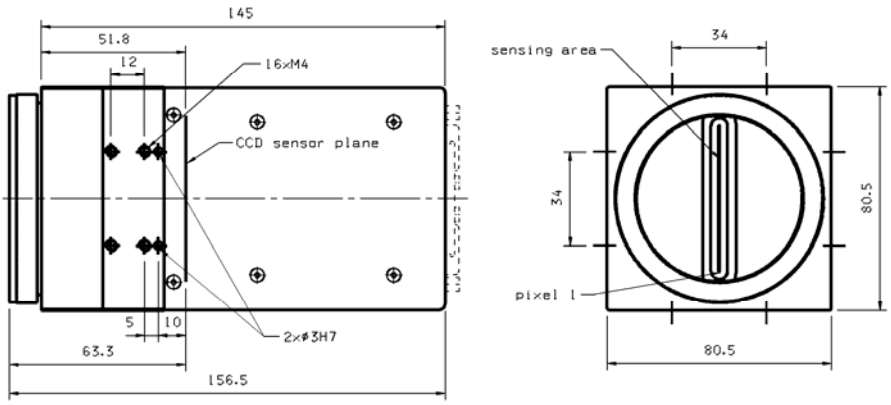
4.4.2 C mount

Dimensions (mm)



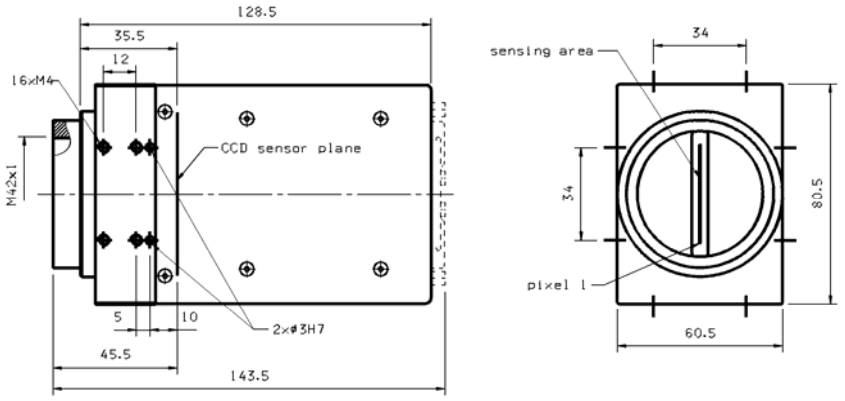
4.4.3 Mamiya 645 mount

Dimensions (mm)



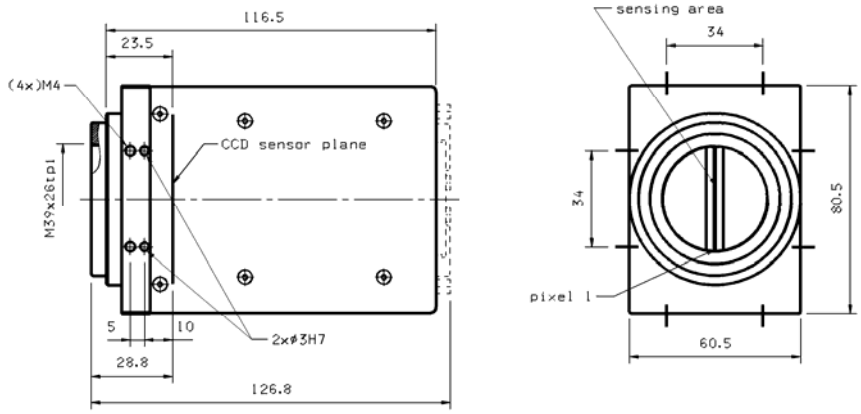
4.4.4 M42 screw mount

Dimensions (mm)



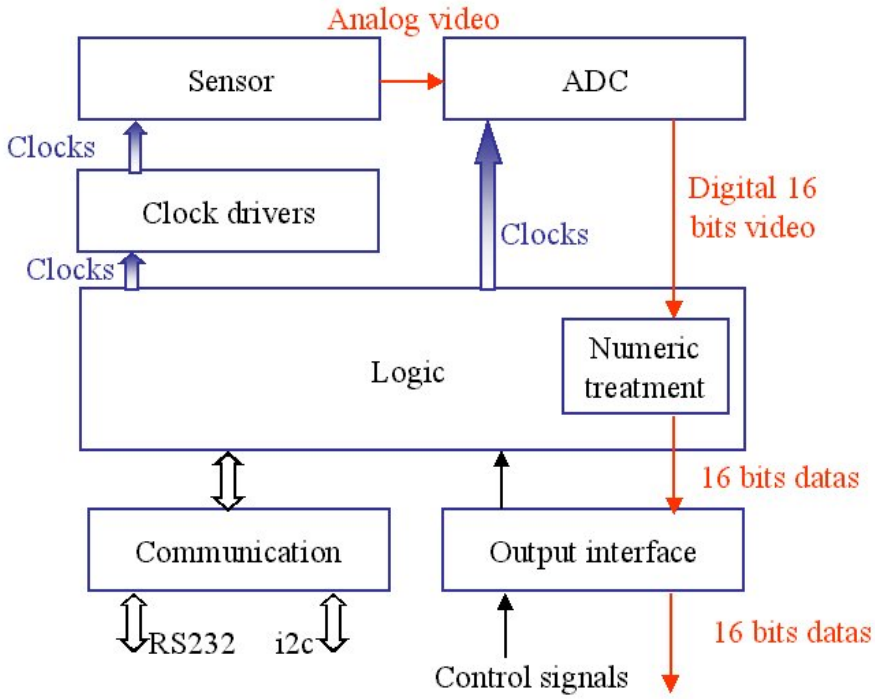
4.4.5 Leica 39 with screws

Dimensions (mm)



5. ELECTRICAL CHARACTERISTICS

5.1 Architecture overview



5.2 Available outputs

DVLs are available in three different data formats :

- RS422
- LVDS (RS644)
- CAMERA LINK

Table of availablility:

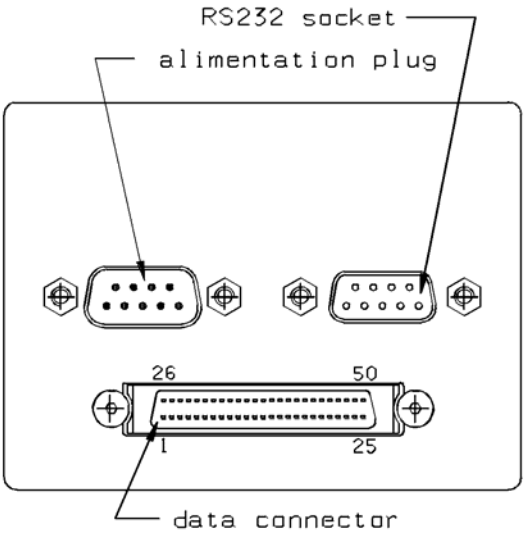
	RS422	LVDS	Camera link
DVL512R	✓ (20MHz)	✓	✓
DVL1024R	✓ (20MHz)	✓	✓
DVL2048RS	✓	✓	
DVL2048S	✓	✓	
DVL2048T	✓	✓	✓
DVL2048R	✓ (20MHz)	✓	✓
DVL2098K	✓	✓	✓
DVL2500T	✓	✓	✓
DVL3750T	✓	✓	✓
DVL5000T	✓	✓	✓
DVL5000T2	✓ (20MHz)	✓	✓
DVL7500T	✓	✓	✓
DVL7500T2	✓ (20MHz)	✓	✓
DVLC2098K	✓ (20MHz)	✓ (60MHz)	✓ (60MHz)

Note : RS422 output is also available in a 8 bits version, compatible with CNL cameras range.

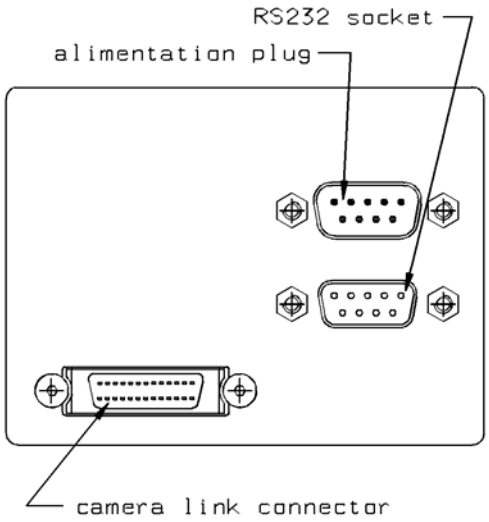
5.3 Location of the connectors

The following drawings show a view of the rear pannel of the camera:

5.3.1 RS422 or LVDS version



5.3.2 Camera link version



5.4 Power supply requirements

5.4.1 General requirements

Maximum electrical consumption	RS422	7 W
	LVDS	6.5 W
	Camera Link	7 W
Peak current at power up	Up to 11 A	

The DVL cameras are fitted with an internal DC-DC converter. The camera is powered with a single voltage power supply. It accepts an input range from 10V DC to 24V DC. We suggest to use a 12V DC power supply. Any switching power supply is suitable to power the camera, assuming that it can drive the peak current at the camera power-on (10 to 11 A). In most cases, the 12V power supply of the computer works fine.
Note that the DVL cameras take a few seconds to initialize after power-up.

There are two ways of supplying the camera, as shown below :

Output format	Supply through the data cable (from the board)	Supply through the DB9 "auxiliary" plug
RS422	YES	YES
LVDS	YES	YES
CAMERA LINK	**NO**[4]	YES

CAUTION Power pins on the data connector and on the auxiliary connector are directly tied together.

So you must not use the two power pins set at the same time

[4] Please refer to the camera link specification (CameraLink5.pdf)

5.4.2 Auxiliary power supply connector

DB9 plug with the following pinout :

1	VIN	Power supply input
2	VIN	Power supply input
3	CMD_RS232_CL	In camera link version : allows external serial line communication
4	EXT_TRIG	Reserved
5	BOOTLDR	Enables boot loader function for firmware upgrading
6	GND	
7	GND	
8	GND	
9	GND	

5.4.3 Power supply through the data cable
In RS422 and LVDS versions only

They are several twisted pairs on the data connector to wire the power supply to the camera. PLEASE CONNECT ALL THE AVAILABLE PAIRS, as it minimises the impedance and the inductance of the leads. You can also use the auxiliary power supply connector.
See the pinout on § 5.6.1.

5.5 RS232 connector

DB9 socket with the following pinout :

2	Tx	Transmits datas from the camera
3	Rx	Receives datas sent to the camera
5	GND	

Case of a camera link version :

The default mode to use serial communication is through the standard camera link cable. To use this external line, it is necessary to strap the pins 3 and 7 of the power supply plug. See § 5.4.2.

5.6 Data connector

5.6.1 Case of a camera with RS422 or LVDS output

Ref: DVLxxxxx/S1 or /S2

A suitable reference from 3M electronics is:

- 10150-3000VE or 10150-6000EL for the plug ,
- 10350-A200-00 for the cover.

Cable requirements

As the numeric datas are transmitted in differential signaling, the differential signal pairs must be cabled on twisted pairs.

The pin-out of the digital connector is as follows:

Pin nb	Signal	Pin nb	Signal		Description
1	VIN	26	GND	I	Power supply
2	VIN	27	GND	I	Power supply
3	VIN	28	GND	I	Power supply
4	PIXCLK+	29	PIXCLK-	O	Pixel clock
5	VDB+	30	VDB-	O	Data valid, active low
6	VIDEO0+	31	VIDEO0-	O	Data LSB
7	VIDEO1+	32	VIDEO1-	O	Data
8	VIDEO2+	33	VIDEO2-	O	Data
9	VIDEO3+	34	VIDEO3-	O	Data
10	VIDEO4+	35	VIDEO4-	O	Data
11	VIDEO5+	36	VIDEO5-	O	Data
12	VIDEO6+	37	VIDEO6-	O	Data
13	VIDEO7+	38	VIDEO7-	O	Data
14	VIDEO8+	39	VIDEO8-	O	Data
15	VIDEO9+	40	VIDEO9-	O	Data
16	VIDEO10+	41	VIDEO10-	O	Data
17	VIDEO11+	42	VIDEO11-	O	Data
18	VIDEO12+	43	VIDEO12-	O	Data
19	VIDEO13+	44	VIDEO13-	O	Data
20	VIDEO14+	45	VIDEO14-	O	Data
21	VIDEO15+	46	VIDEO15-	O	Data MSB
22	CIEXT+	47	CIEXT-	I	Line clock
23	SCL	48	GND	I	I2C bus clock
24	SDA	49	GND	I/O	I2C bus data
25	GND	50	GND		

These signals are described in paragraph 6

5.6.2 Case of a camera with CAMERA LINK output ref DVLxxxxx/S3

Connection : camera link base configuration
The pinout is defined in the Camera link specification (CameraLink5.pdf)

The control signals are as follows :

	Camera link interface	DVL interface
Input	CC1	CIEXT
Output	LVAL	Not(VDB)

These signals are described in paragraph 6

6. NUMERIC SIGNALS

6.1 Description

Basically, all the cameras of the DVL range use the same set of signals transmitted in a differential mode signaling.

These signals are :

- The pixel clock **PIXCLK**. This signal is an output from the camera.
- The **VDB** signal is an output from the camera that indicates the pixels to grab. This signal is active low. Note that you reverse the polarity of this signal if you swap the plus and minus wire of the twisted pair.
- The sixteen bits of digital video output: **VID[15:0]**. In most cases, it is safe to clock the digital video with the rising edge of PIXCLK, assuming that your hardware doesn't delay the PIXCLK signal more than the VID bus. Indeed, the hold time of the video after the rising edge of PIXCLK is greater than 15ns.
- The **CIEXT** signal which is an input of the camera. This signal is synchronised internally with PIXCLK. CIEXT starts the readout of the CCD device. Thus the line period is the period of CIEXT. For the cameras which doesn't provide a shutter function, CIEXT period is also the exposure time. For cameras with shutter capability, the falling edge of CIEXT will start the exposure period, the rising edge of CIEXT will terminate the exposure period and trig the readout.

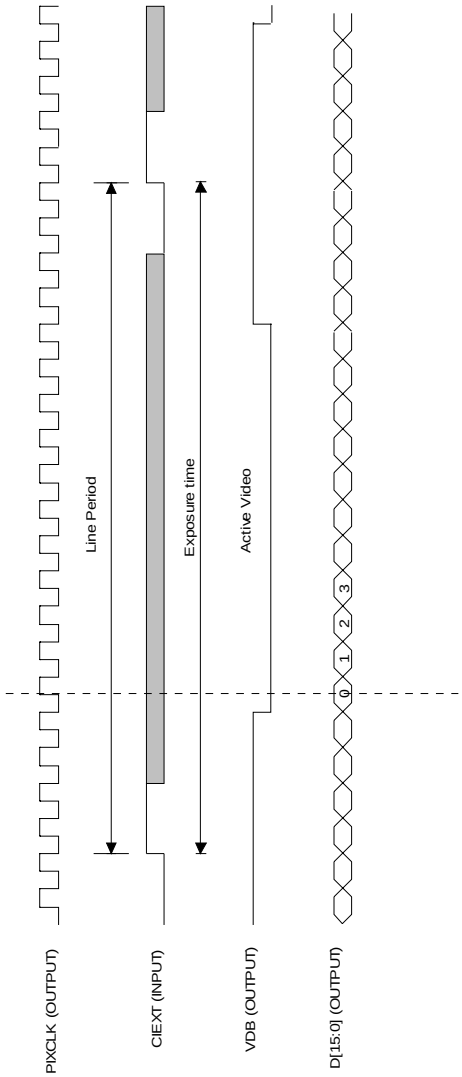
Cameras	Inactive pixels before	Active pixels	Inactive pixels after	Vdb delay	Re-triggering time
DVL512R	0	512	0	55	6
DVL1024R	0	1024	0	55	6
DVL2048RS	0	2048	2	75	10
DVL2048S	0	2048	11	75	1
DVL2048T	0	2048	8	85	8
DVL2048R	0	2048	0	55	6
DVL2098K	0	2098	0	82	14
DVL2500T	0	2500	0	98	8
DVL3750T	0	3750	5	98	3
DVL5000T	0	5000	0	186	16
DVL5000T2	0	5000	0	186	16
DVL 7500T	0	7500	10	186	6
DVL 7500T2	0	7500	10	186	6
DVLC 2098K	0	2098 X 3	0	141	42

Vdb delay : number of clock cycles between a rising edge of Ciext and the falling edge of vdb

Re-triggering time : minimum number of clock cycles between a rising edge of vdb and the next rising edge of ciext.

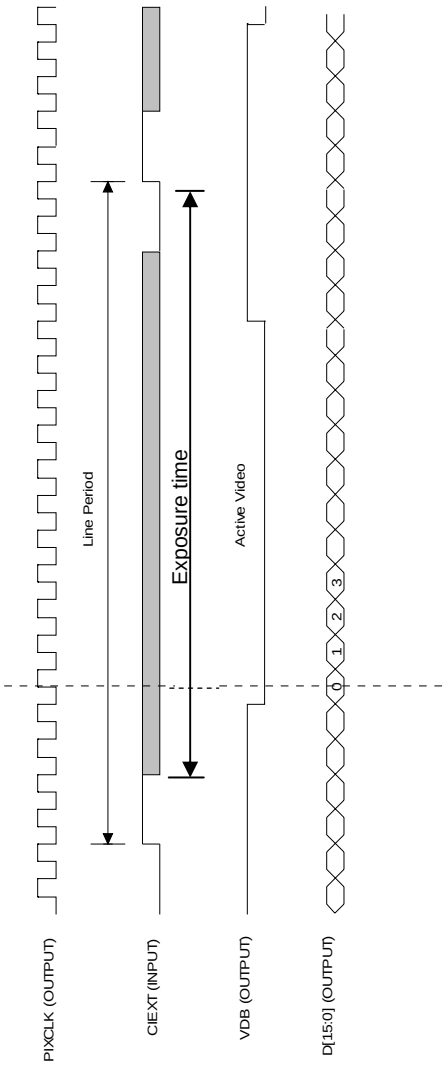
6.2 Timing diagram

6.2.1 Continuous mode



6.2.2 Exposure control

Applies to cameras with electronic shutter or emulated shutter.
For emulated shutter's use, please refer to application note (AN_emulated_Shutter2.pdf)



7. USER SETTINGS

7.1 Using RS232 line

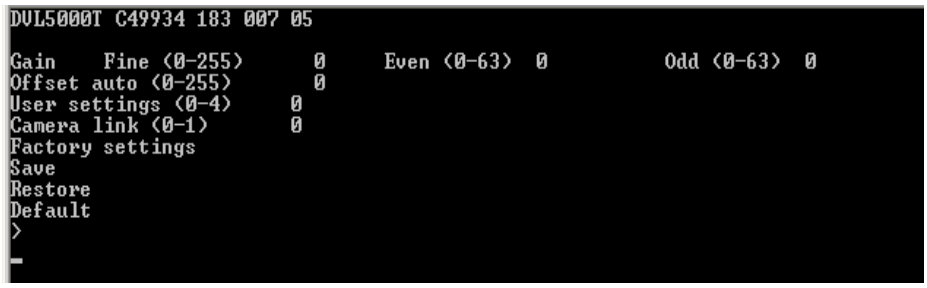
Some parameters of DVLs can be set up by users via serial line.
This uses the RS232 socket at the rear panel of the camera, or the internal RS232 for camera link versions.

Communication characteristics :
Speed : 19200 Bauds
Data bits : 8
Parity : None
Stop bits : 1

This interface allow to change gain value, offset control, video signal filtering, shutter mode selection (if available), test pattern selection, output format (camera link version only).
In the following paragraphs, DVLs are sorted depending on their own setup menu.

7.1.1 Your camera is a DVL2500T, DVL5000T, DVL5000T2 DVL3750T, DVL7500T, DVL7500T2

Outline of the menu :



Menu	Cmd	Range value	Function
Even Gain	GE	0-63	Coarse gain value. Applies on even line. Ranges from x1 to x6[5]
Odd Gain	GO	0-63	Coarse gain value. Applies on odd line. Ranges from x1 to x6[6]
Fine Gain	GF	0-255	Fine gain adjusdment : from x1 to x2, by 1/256 steps
Offset auto	O	0-255	Auto offset control. Dark level is controlled equal to the chosen value (in 16bits LSB) 0 means no offset control.
User settings	U	0xAB A : 0 ; 2 B : 0-4	A : cameras with shutter[7] : ▪ 0 : continuous mode ▪ 2 : exposure control mode[8] For cameras without shutter, this value is set to 0
			B : Low pass filter choice / test pattern selection : ▪ 0 : no filter ▪ 1 : averaging on a 2 pixels window ▪ 2 : averaging on a 4 pixels window ▪ 3 : 3 pixels wide median filter ▪ 4 : test pattern (see chapter 8 : Appendix : test pattern)
Camera link	C	0 ; 1	Select output format : ▪ 0 : 16 bits ▪ 1 : 8 bits
Factory settings	F	--	Protected
Save	S	--	Saves user settings

[5] Effective gain = 6 / (1 + 5.0 (63-G)/63))

[6] Effective gain = 6 / (1 + 5.0 (63-G)/63))

[7] Electronic shutter or emulated shutter.

[8] In the case of a 8 bits RS422 version (DVLxxxx/S0) the value must be set to 1.

Menu	Cmd	Range value	Function
Restore	R	--	Restores previously saved user settings
Default	D	--	Factory settings recovery

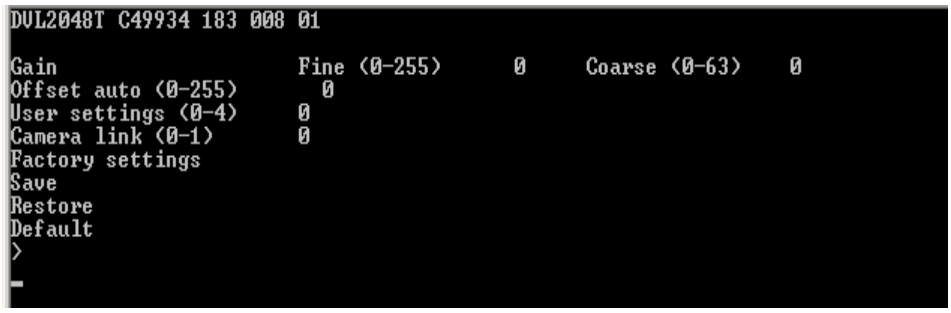
7.1.2 Your camera is a DVL2048RS

Outline of the menu :

Menu	Cmd	Range value	Function
Fine Gain	GF	0-255	Fine gain adjusdment : from x1 to x2, by 1/256 steps
Offset auto	O	0-255	Auto offset control. Dark level is controlled equal to the chosen value (in 16bits LSB) 0 means no offset control.
User settings	U	0xAB B : 0-4	A : not active : this value is set to 0 B : Low pass filter choice / test pattern selection : ▪ 0 : no filter ▪ 1 : averaging on a 2 pixels window ▪ 2 : averaging on a 4 pixels window ▪ 3 : 3 pixels wide median filter ▪ 4 : test pattern (see chapter 8 : Appendix : test pattern)
Factory settings	F	--	Protected
Save	S	--	Saves user settings
Restore	R	--	Restores previously saved user settings
Default	D	--	Factory settings recovery

7.1.3 Your camera is a DVL2048S, DVL2048T, DVL2098K, DVL512R, DVL1024R, DVL2048R

Outline of the menu :



Menu	Cmd	Range value	Function
Coarse Gain	GC	0-63	Coarse gain value. Ranges from x1 to x6[9]
Fine Gain	GF	0-255	Fine gain adjusdment : from x1 to x2, by 1/256 steps
Offset auto	O	0-255	Auto offset control. Dark level is controlled equal to the chosen value (in 16bits LSB) 0 means no offset control.
User settings	U	0xAB A : 0 ou 2 B : 0-4	A : cameras with shutter[10] : ▪ 0 : continuous mode ▪ 2 : exposure control mode[11] For cameras without shutter, this value is set to 0
			B : Low pass filter choice / test pattern selection : ▪ 0 : no filter ▪ 1 : averaging on a 2 pixels window ▪ 2 : averaging on a 4 pixels window ▪ 3 : 3 pixels wide median filter ▪ 4 : test pattern (see chapter 8 : Appendix : test pattern)
Camera link	C	0 ; 1	Select output format : ▪ 0 : 16 bits ▪ 1 : 8 bits
Factory	F	--	Protected

[9] Effective gain :

- ❖ DVL2048T : 20 Log(Effective gain) = 0.0353 x (370.G / 63 + 95)
- ❖ DVLXXXXR : 20 Log(Effective gain) = 0.035 x (452.G / 64)
- ❖ Others : Effective gain = 6 / (1 + 5.0 (63-G)/63))

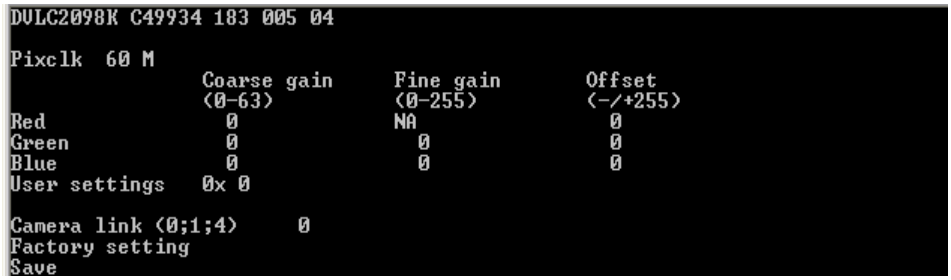
[10] Electronic shutter or emulated shutter.

[11] In the case of a 8 bits RS422 version (DVLxxxx/S0) the value must be set to 1.

Menu	Cmd	Range value	Function
settings			
Save	S	--	Saves user settings
Restore	R	--	Restores previously saved user settings
Default	D	--	Factory settings recovery

7.1.4 Your camera is a DVLC2098K

Outline of the menu :



Menu	Cmd	Range value	Function
Pixclk	P	40 ; 50 ; 60	Selects the value of pixel clock frequency in MegaHertz[12] In multiplexed mode (1x16 or 1x8 bits), pixel clock frequency = P In 3x8 bit mode, pixel clock frequency is P divided by 3 (e.g. 13.3, 16.7, 20 MHz)
Coarse gain	RC GC	0-63	Coarse gain value on each channel (Red, green, blue).

[12] On Camera link and LVDS versions only

Menu	Cmd	Range value	Function
	BC		Ranges from x1 to x6[13]
Fine gain	RC[14] GF BF	0-255	Fine gain adjusdment on green and blue channels : from x1 to x2, by 1/256 steps
Offset	RO GO BO	-255/+255	Offset setting on each channel (1.17 mV by step) No offset control is available on this camera
User settings	U	0xAB A : 0 ou 2 B : 0-4	A : shutter setting : ▪ 0 : continuous mode ▪ 2 : exposure control mode[15]
			B : Low pass filter choice / test pattern selection : ▪ 0 : no filter ▪ 1 : averaging on a 2 pixels window ▪ 2 : averaging on a 4 pixels window ▪ 3 : NA ▪ 4 : test pattern (see chapter 8 : Appendix : test pattern)
Camera link	C	0 ; 1 ; 4	Select output format : ▪ 0 : 16 bits multiplexed ▪ 1 : 8 bits multiplexed ▪ 4 : 3 x 8 bits parallel (@20MHz each)
Factory settings	F	--	Protected
Save	S	--	Saves user settings
restOre	O	--	Restores previously saved user settings
Default	D	--	Factory settings recovery

[13] Effective gain = 6 / (1 + 5.0 (63-G)/63))

[14] Red fine gain available on 20 MHz RS422 version only

[15] In the case of a 8 bits RS422 version (DVLxxxx/S0) the value must be set to 1

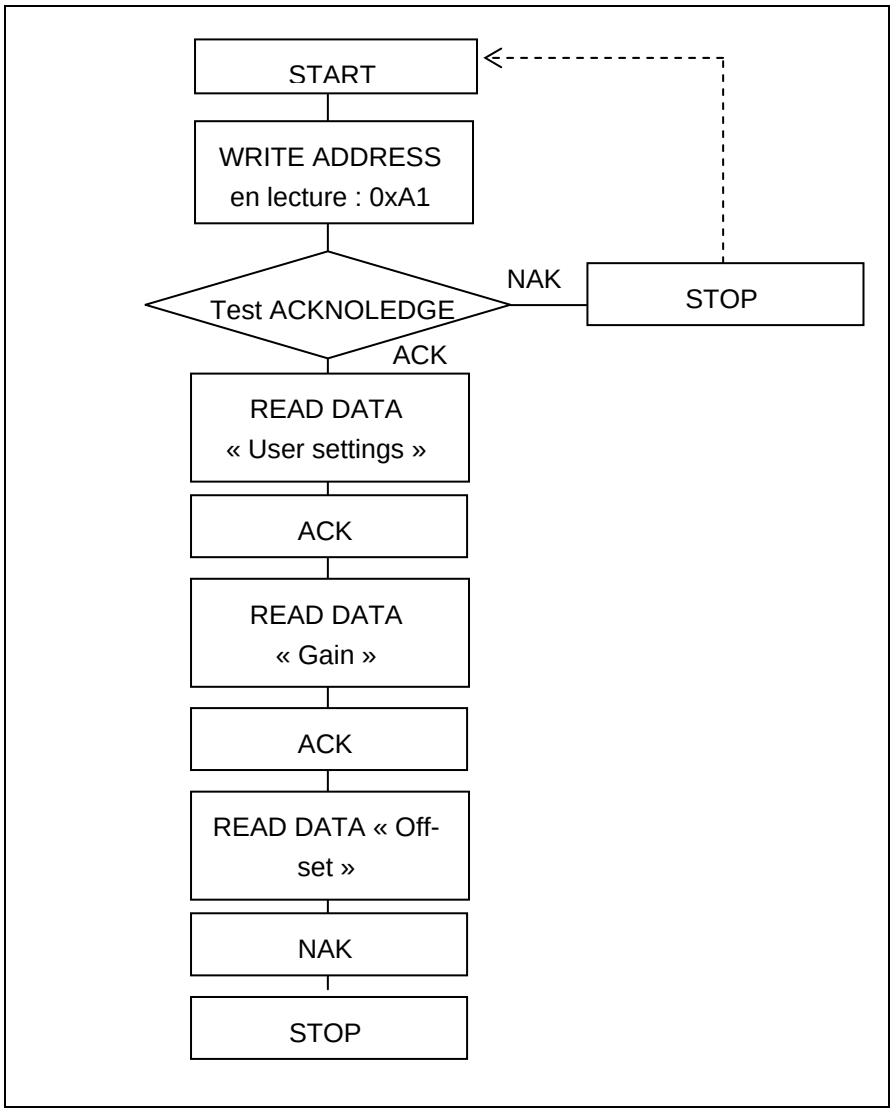
7.2 Using I2C bus

The user settings of DVL cameras can be made by I2C bus
The SCL and SDA signals are mastered by the framegrabber.

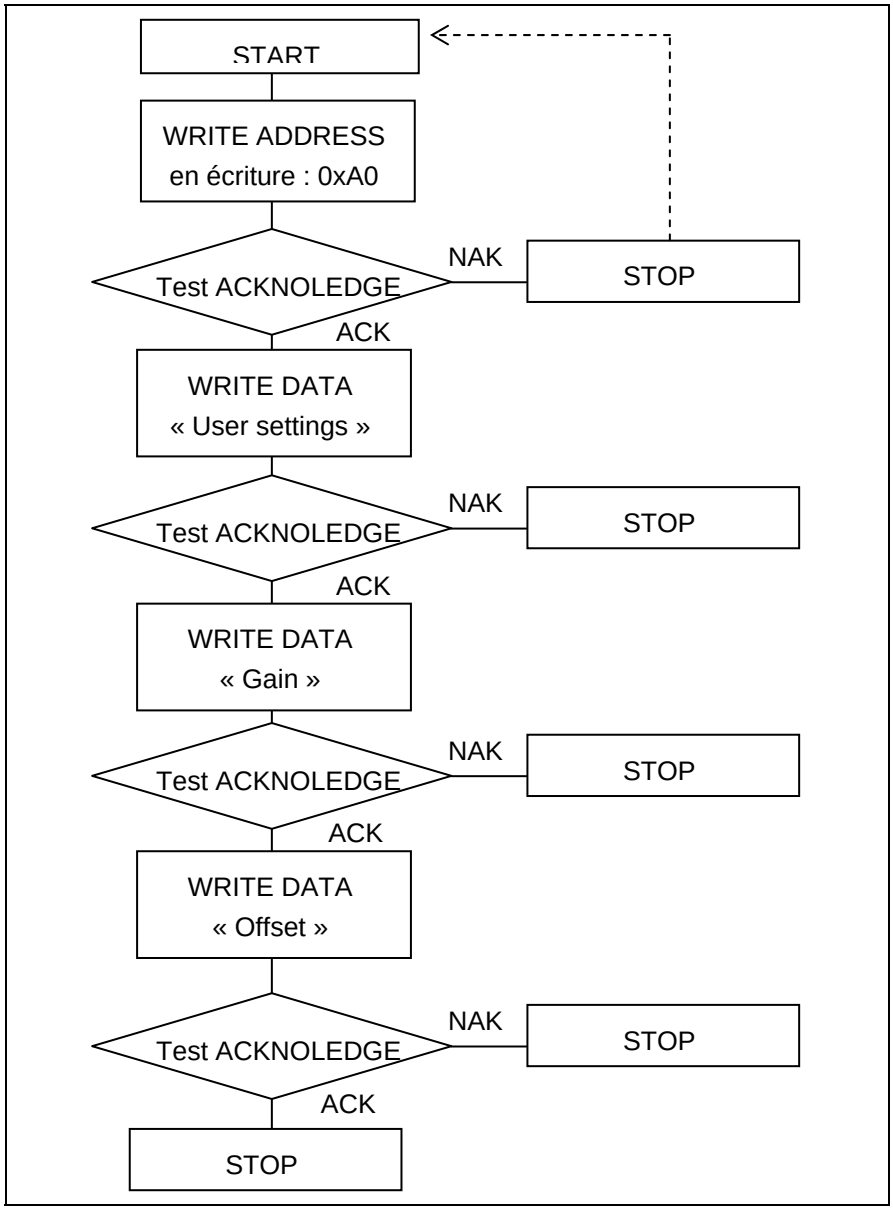
The accessible registers are the same as for RS232 access.

The following diagrams describe the cycle for read and write access.

Read access :


START
WRITE ADDRESS
en lecture : 0xA1
Test ACKNOLEDGE
NAK
STOP
ACK
READ DATA
« User settings »
ACK
READ DATA
« Gain »
ACK
READ DATA « Off-
set »
NAK
STOP

Write access :



8. APPENDIX : TEST PATTERN

The DVL cameras feature a buit-in test pattern. It can be activated via serial line (see paragraph “user settings”).
It can be used to check data integrity along the data path.
The pattern is made of 15 bits high and one bit low moving from one bit to another as described in the table below.
Download the complete file in text format (pattern.txt)

	Pixel number	Test pattern value (decimal)	Test pattern value (hexadecimal)
	0	65534	0xFFFE
Repetitive pattern	1	65534	0xFFFE
	2	65533	0xFFFD
	3	65531	0xFFFB
	4	65527	0xFFF7
	5	65519	0xFFEF
	6	65503	0xFFDF
	7	65471	0xFFBF
	8	65407	0xFF7F
	9	65279	0xFEFF
	10	65023	0xFDFF
	11	64511	0xFBFF
	12	63487	0xF7FF
	13	61439	0xEFFF
	14	57343	0xDFFF
	15	49151	0xBFFF
	16	32767	0x7FFF
	17	65534	0xFFFE
	18	65533	0xFFFD
	19	65531	0xFFFB
	20	65527	0xFFF7

	21	65519	0xFFEF
	22	65503	0xFFDF
	23	65471	0xFFBF
	24	65407	0xFF7F
	25	65279	0xFEFF
	26	65023	0xFDFF
	27	64511	0xFBFF
	28	63487	0xF7FF
	29	61439	0xEFFF
	30	57343	0xDFFF
	31	49151	0xBFFF
	32	32767	0x7FFF
	33	65534	0xFFFE
	...	...	...